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(54) Abstract Title
Flexible electric fence material including a steel wire with a conductive coating

(57) A flexible electric fence material 1, which may be a cable or a tape, comprises a non-conducting plastic fibre 2 (e.g. polythene, polyester or polypropylene), and an electrically conducting wire 3 running jointly therewith, which is made of unalloyed low-carbon steel with a corrosion-resistant electrically conducting coating. The coating may be made of one or more of copper, zinc, nickel, chromium, tin and tin/lead and may be electrolytically-galvanically applied. The coating may be two-layered with an inner copper layer and an outer layer made of one of the other materials.

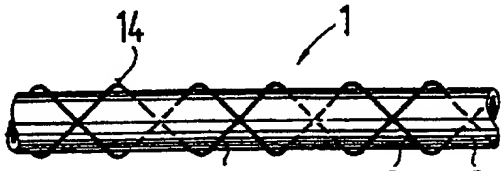

FIG.1

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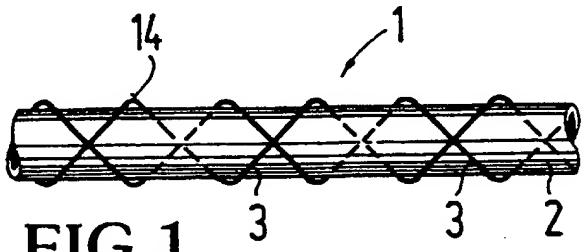

FIG. 1

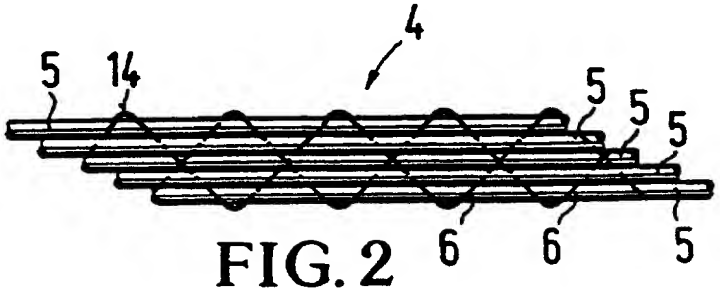

FIG. 2

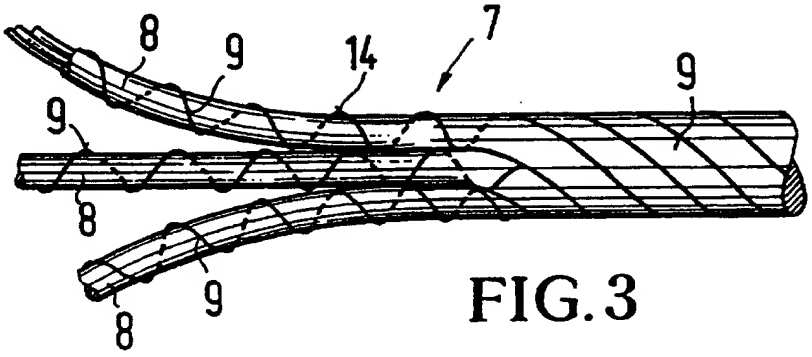

FIG. 3

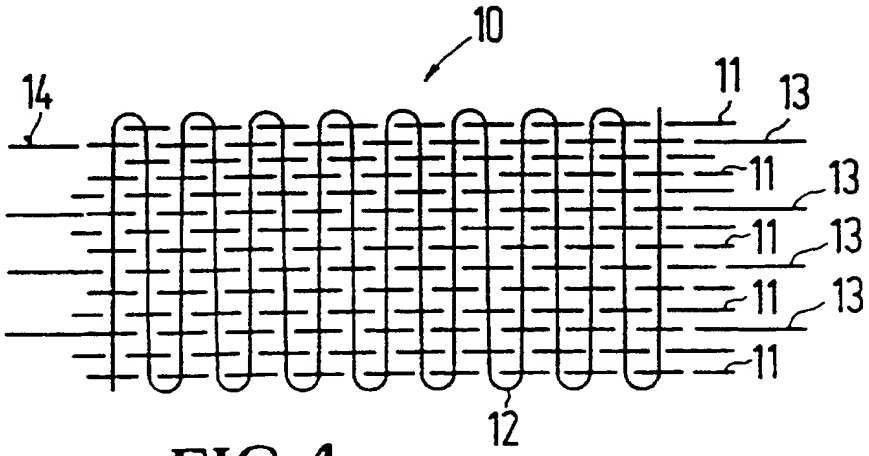

FIG. 4

Flexible Electric Fence Material

The invention relates to flexible material suitable for use in setting up an electric fence.

More particularly, but not exclusively, the invention relates to fencing flexes, wide fencing tapes and fencing cables, each consisting of non-conducting fibres, especially plastics fibres of polyamide, polyester, polypropylene or the like, and one or more conducting wires which have been plaited into, knitted into, woven into, wound around or incorporated in some other way into the non-conducting fibres, and to a method for the production thereof.

Fencing flexes, wide fencing tapes and fencing cables are used for enclosing pastureland. Modern and humane methods of keeping livestock make it increasingly necessary to be able to utilise pasture areas quickly and to erect fencing and remove it again within as short as possible a time at the lowest possible cost. The boundary of the pasture area should be formed by fencing that, on the one hand, is secure against break-out but, on the other hand, presents no risk of injury to the animals. Since the fencing will constantly be exposed to considerable environmental effects, it must be relatively unsusceptible to corrosion. This should be accompanied, however, by operating costs that are as low as possible.

The electrically operated fencing currently available fulfils those demands with varying degrees of success. The fencing can be divided into four categories on the basis of its structure:

Round monoflexes are available that consist of insulating plastics, such as, for example, polyamide, especially nylon, polyethylene and polypropylene, around which there are wound one or more electrically conducting wires of iron, copper or the like.

A second group consists of a round plaited cord of insulating plastics flexes into which one or more electrically conducting wires of copper, non-rusting steel or the like have been plaited.

A third group consists of a plurality of single flexes of plastics around each of which there are wound separately one or more conducting steel wires and/or copper wires, the flexes then in turn being stranded together to form a common complete fencing flex or a fencing cable. Such a fencing flex or fencing cable is known from EP 0 256 841 B1.

A fourth group relates to wide fencing tapes which are woven or made using a plurality of warp threads and weft threads of plastics material. Depending upon the

width of the tape, a number of copper wires or a number of non-rusting steel wires are woven, knitted or worked into the tape next to one another as warp threads.

In such fences the metal wires are used on the one hand to take up the tensile stress of the tautly stretched fencing tape or flex or cable and on the other hand to transmit the electrical voltage. The current source used to operate the electric fencing is usually a portable accumulator or battery apparatus of suitable output, a battery or a mains power pack connected to a permanently installed current source.

As can be seen from EP 0 256 841 B1, it has already been proposed to fulfil the above-described demands made of the metal wires by using two different wires each of which has the necessary mechanical and electrical properties. One wire serves to take up the tensile and stretching forces in question, while the other wire has to provide good electrical conductivity. There are used as tension wires especially noble steel wires, that is to say non-rusting steel wires, that are unsusceptible to corrosion in respect of most of the substances occurring in nature, such as acids, caustic solutions, fertilizers and animal excrement, such as faeces and urine. Those noble steel wires are generally high-alloy rust- and acid-resistant steels with a number of alloy elements, such as, for example, C, Si, Mn, P, S, Cr, Mo, Ni, V. For fencing it is preferred to use a high-alloy noble steel wire X 5 CrNi 189.

Since, however, those rust-resistant and acid-resistant noble steel wires have a relatively high specific electrical resistance and therefore a relatively low electrical conductivity, fencing consisting exclusively of such a metal wire would require the output of the voltage source to be greater the longer the length of fencing, in order that contact with the wire at the end of a long fence would still register a perceptible "shock". In the case of the subject of EP 0 256 841 B1 the current is therefore carried by an additional wire of an especially conductive material, such as copper. Those copper wires have a low electrical resistance, but, with the small diameter required, they are unsuitable for high mechnical tensile stresses.

The problem underlying the invention is therefore to provide fencing flexes, wide fencing tapes and fencing cables of the type mentioned at the beginning that require only one kind of conducting wires, in which the disadvantages of the relatively high electrical resistance of non-rusting steel (noble steel) are overcome, without the high mechanical tensile strength of the wire and the corrosion resistance of the wire being reduced.

The present invention provides a flexible electric fence material consisting of at least one electrically non-conducting member and at least one electrically conducting wire running jointly therewith, in which the electrically conducting wire is made of steel and has a corrosion-resistant, electrically conducting coating.

The above-mentioned problem can be solved according to the invention by the provision of electrically conducting wires that consist of an unalloyed steel and have a corrosion-resistant, electrically conducting coating.

Unalloyed steel wires have a considerably higher electrical conductivity than the noble steel wires used hitherto for fencing. The unalloyed steel wire is provided with the corrosion resistance necessary for use as fencing wire by an electrically conducting coating. The electrically conducting wires according to the invention therefore have both the mechanical and the electrical properties necessary for fencing. Since only a single kind of wire is required for the production of the fencing flexes, wide fencing tapes and fencing cables, production is very much simplified. The replacement of the very expensive high-alloy steel wires and copper wires also allows costs to be kept low. In addition, there is no longer a risk that the copper wire, which is not particularly resistant to external mechanical influences, will tear, resulting in an interruption in the current supply. That technical problem is said to be solved in accordance with EP 0 274 454 B1 by having the various electrically conducting wires connected to one another in sections by continuous bridge conductors. Such additional outlay is unnecessary with the present invention.

In accordance with a preferred variant of the invention the surface-coated (using a nobler metal), electrically conducting wires consist of an unalloyed, low-carbon steel, especially a steel according to DIN 17111. Such steel wires have a specific electrical resistance that is about from 5 to 6 times lower, and consequently a from 5 to 6 times higher electrical conductivity, than that of the high-alloy, rust- and acid-resistant noble steel wires according to DIN 17440, for example X 5 CrNi 189, employed hitherto for fencing.

It has been shown that surface-coated, electrically conducting wires of an unalloyed carbon-enriched steel, as described, for example, in DIN 17140, also have such properties.

The unalloyed high-grade steel used according to the invention is advantageously provided with a corrosion-resistant, electrically conducting coating.

According to the invention, the coating may consist of one or more of the elements copper, nickel, zinc, chromium, tin and tin/lead.

In a development of that inventive concept, the corrosion-resistant, electrically conducting coating is applied electrolytically-galvanically. The electrically conducting coating can, however, advantageously be applied also in a hot-tinning process or hot-zincing process.

A further possible use of such unalloyed high-grade steels according to the invention is the use of copper-plated steel wires. In those wires a copper strip is laid, in a constant passage through of wire, continuously around a thick steel core in the longitudinal direction and is welded along the longitudinal seam. Together with the inner steel core, the copper-plated steel wires are then drawn down to a desired diameter.

The corrosion protection of those unalloyed high-grade steels is provided by the closed copper casing which, however, oxidises in the open air and therefore has a lower conductivity at the surface, and also becomes darker in colour. According to the invention, therefore, the copper-plated steel wires are provided with a further conducting surface-coating by means of an electrolytic-galvanic process, hot-tinning process or hot-zincing process. According to the invention, the conducting surface-coating may consist of the elements tin, zinc, nickel, chromium or tin/lead.

In a use according to the invention for fencing flexes, wide fencing tapes and fencing cables, the copper-plated and possibly also surface-coated steel wires also have the great advantage that the copper-plated steel wires have, according to the thickness of the copper casing, a specific electrical resistance that is about from 10 to 17 times lower, and consequently an electrical conductivity that is from 10 to 17 times higher, than the rust- and acid-resistant steels according to DIN 17440 used hitherto.

Flexible electric fencing material constructed in accordance with the invention and methods of making it will now be described, by way of example only, with reference to the accompanying drawings, in which:

Fig. 1 shows a round monoflex of insulating plastics with two electrically conducting wires according to the invention,

Fig. 2 shows a round plaited cord of insulating plastics flexes, likewise with two electrically conducting wires according to the invention,

Fig. 3 shows some single flexes of plastics each wound around with electrically conducting wires according to the invention, the flexes being stranded to form a common fencing flex or fencing cable, and

Fig. 4 shows a wide fencing tape with a plurality of non-rusting wires according to the invention.

All the features described and/or illustrated in the drawings, alone or in any combination, form subject-matter of the invention, irrespective of how they are combined in the claims or the appendency thereof.

Referring to the accompanying drawings, the fencing flexes, fencing tapes and fencing cables shown in Figs 1 to 4 each consist of non-conducting plastics fibres, for example of polyamides (nylon), polyethylene or propylene, into which there have been plaited, knitted, woven, wound or introduced in some other way one or more electrically conducting wires of an unalloyed steel having a corrosion-resistant, electrically conducting coating 14.

The monoflex 1 shown in Fig. 1 consists of a single round plastics flex 2 of nylon, polyethylene, polypropylene or the like and in the embodiment shown has wound around it two surface-coated, unalloyed, low-carbon steel wires 3 of low electrical resistance which serve as current conductors.

The fencing flex or fencing cable according to Fig. 2 consists of a round plaited cord of insulating plastics flexes 5 in the form of monofilaments or small strips, likewise of polyethylene, polypropylene, nylon or the like. Plaited into the plaited cord are a number of surface-coated, electrically conducting wires 6 of an unalloyed, low-carbon steel.

The fencing flex or fencing cable 7 shown in Fig. 3 consists of a plurality of single flexes 8 in the form of monofilaments or small strips of plastics, such as polyethylene, polypropylene, nylon or the like, around each of which there are wound one or more surface-coated, electrically conducting wires 9 of a low-carbon unalloyed steel. As can be seen from the Figure, the individual flexes 8 are stranded together to form a single fencing flex or a single fencing cable 7.

The wide fencing tape 10 shown in Fig. 4 is woven using a plurality of warp threads 11 and weft threads 12 of plastics fibres, especially polyethylene, polyamides (nylon) or the like. Depending upon the width of the tape, a number of surface-coated, electrically conducting wires 13 are woven, knitted or worked into the tape next to one another as warp threads.

As can be seen from the following Table, the specific electrical resistance of the low-carbon, unalloyed steel wires is about from 5 to 6 times lower than the specific electrical resistance of the noble steel wire X 5 CrNi 189 preferably used hitherto for fencing. Accordingly, the electrical conductivity is therefore from 5 to 6 times higher than that of the noble steel wires used hitherto. In the case of copper-clad steel wires, the electrical resistance is even from 10 to 17 times lower than in the case of noble steel wires according to DIN 17440.

	Tensile strength (medium hard) Rm [N/mm^2]	Spec. electrical resistance ρ $\frac{\Omega \cdot mm^2}{m}$	Spec. electr. conductivity λ $\frac{m}{\Omega \cdot mm^2}$	Electrical resistance R [Ω/m]
Rust- and acid-resistant steel, e.g. X 5 CrNi 189 - diameter 0.30 mm	800	0.718	1.39	10.3
Unalloyed low-carbon steel acc. to DIN 17111 or DIN 17140 material D6-2- diameter 0.28 mm	800	0.130	7.69	2.05
Unalloyed steel acc. to DIN 17111 or DIN 17140; copper-plated acc. to ASTM-B 452 conductivity 30% IACS diameter 0.30 mm	800	0.057	17.54	0.80

CLAIMS:

1. Flexible electric fence material consisting of at least one electrically non-conducting member and at least one electrically conducting wire running jointly therewith, in which the electrically conducting wire is made of steel and has a corrosion-resistant, electrically conducting coating.

2. Material as claimed in claim 1, wherein the material is in the form of a wire or cable.

3. Material as claimed in claim 1, wherein the material is in the form of a tape.

4. Material as claimed in any preceding claim, wherein the at least one non-conducting member is made of plastics material.

5. Material as claimed in claim 4, wherein the at least one non-conducting member is made of polyethylene, polyester or polypropylene.

6. Material as claimed in any preceding claim, wherein a plurality of non-conducting members are provided.

7. Material as claimed in claim 6, wherein the at least one conducting member is incorporated into the non-conducting members.

8. Material as claimed in claim 7, wherein the at least one conducting member is knitted into or woven into the non-conducting members.

9. Material as claimed in any one of claims 1 to 6, wherein the at least one conducting member is wound around the at least one non-conducting fibre.

10. Material as claimed in any preceding claim, wherein the steel is an unalloyed steel.

11. Material as claimed in claim 10, wherein the steel is low-carbon steel.

12. Material as claimed in any preceding claim, wherein the at least one conducting member has an electrical resistance from 5 to 6 times lower, and consequently an electrical conductivity from 5 to 6 times higher, than a rust- and acid-resistant steel wire according to DIN 17440.

13. Material as claimed in claim 11, wherein the at least one non-conducting member consists of a low-carbon, unalloyed steel according to DIN 17111.

14. Material as claimed in claim 10, wherein the at least one conducting member consists of an unalloyed, carbon-enriched steel.

15. Material as claimed in claim 10, wherein the at least one conducting member consists of an unalloyed high-grade steel according to DIN 17140.

16. Material as claimed in any preceding claim, wherein the corrosion-resistant, electrically conducting coating consists of one or more of the elements copper, nickel, zinc, chromium, tin and tin/lead.

17. Material as claimed in claim 16, wherein the corrosion-resistant, electrically conducting coating is an electrolytically-galvanically applied coating.

18. Material as claimed in any one of claims 1 to 16, wherein the corrosion-resistant, electrically conducting coating has been applied in a hot-tinning process.

19. Material as claimed in any one of claims 1 to 16, wherein the corrosion-resistant, electrically conducting coating has been applied in a hot-zincing process.

20. Material as claimed in any one of claims 1 to 16, wherein the corrosion-resistant, electrically conducting coating has been applied or rolled on by means of a mechanical copper-plating process.

21. Material as claimed in claim 20, wherein there has been applied to the copper-plated surface a further corrosion-resistant, electrically conducting coating of one or more of the elements nickel, zinc, chromium, tin or tin/lead.

22. Material as claimed in claim 12, wherein the further corrosion-resistant, electrically conducting coating of the copper-plated surface has been applied by means of an electrolytic-galvanic process, by means of a hot-tinning process or by means of a hot-zincing process.

23. Flexible electric fence material substantially as herein described, with reference to, and as illustrated by, Figure 1 of the accompanying drawings.

24. Flexible electric fence material substantially as herein described, with reference to, and as illustrated by, Figure 2 of the accompanying drawings.

25. Flexible electric fence material substantially as herein described, with reference to, and as illustrated by, Figure 3 of the accompanying drawings.

26. Flexible electric fence material substantially as herein described, with reference to, and as illustrated by, Figure 4 of the accompanying drawings.

27. A method of producing material as claimed in any one of claims 20 to 22, wherein a copper strip is laid, in a constant passing through of wire, continuously around a thick steel core in the longitudinal direction and is welded along the longitudinal seam, and thereafter the copper-plated steel wire together with the inner steel core are drawn down to a predetermined diameter.

The Patent Office

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Application No: GB 9723710.1
Claims searched: 1-27

Examiner: Richard Nicholls
Date of search: 26 May 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): H1A (AKR, AC) ; E1D (DF109LC, DF109LE) ; E1K (K18)

Int Cl (Ed.6): H01B 5/00, 5/10 ; H05C 1/00, 1/02, 1/04, 1/06, 3/00

Other: Online databases : WPI, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
Y	GB 1156540 A	(NATIONAL STANDARD) see especially page 1 lines 11-14	1 at least
Y	GB 0794456 A	(R.S.D.I.) see especially figure 1A and page 2 lines 26	1 at least
Y	GB 0534715 A	(NATIONAL STANDARD) see especially figure 2	1 at least
Y	US 5151319	(SCHOUTTETEN) see especially figure 2	1 at least
Y	US 3291897	(BRAMLEY) see especially figures 1 and 3	1 at least

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